

### **Remarks/ Arguments**

Upon entry of the foregoing amendments, Claims 1 to 4, 6 to 11, 15 to 17 and 21 to 32 will be pending in this patent application. Claims 1, 6, 15, 16, 17, 21, 22, 23 and 25 have been amended, without prejudice. Claims 12, 13, 14 and 19 have been canceled with this amendment without prejudice. Claims 5, 18 and 20 have been canceled previously, without prejudice. Support for the amendments is found in Applicants' specification at, for example, page 5, line 7; page 5, lines 31 to 32; page 12, lines 4 to 5; page 15, line 13 to page 16, line 1. Claims 26 to 32 are new. Support for new claims 26 to 32 is found in Applicants' specification at, for example, page 15, line 13 to page 16, line 1.

The Action includes rejections under 35 U.S.C. §§ 103(a) and 112, second paragraph. In view of the foregoing amendments and the following remarks, reconsideration and withdrawal of the rejections are requested respectfully.

### **Summary of Examiner Interview**

Applicant, Eric Klingenberg, Ph.D., and Applicant's representative, Joseph Rossi, wish to thank Examiner Sergent for the opportunity of a personal interview on June 19, 2007. During the interview, Applicant discussed the differences between the claimed invention and the applied prior art. Applicants presented experimental data showing the surprising and unexpected results obtained when the claimed steps are performed in their recited sequence. Specifically, Dr. Klingenberg presented data showing the narrow particle size distribution of the claimed aqueous polyurethane dispersions prepared by the claimed methods of the invention. Dr. Klingenberg also presented sample films of the polyurethane dispersions having a molecular weight range within the range recited by the claimed invention (40,000 to 60,000 g/mol) versus polyurethane films made with polyurethanes outside of the claimed range. Dr. Klingenberg showed Examiner Sergent that films made

from polymers within the recited range were able to completely cover the substrate upon which they were formed (with no air gaps) and exhibited the properties necessary to be used as an adhesive for electronic applications. Although no agreement was reached at the interview, Examiner Sergent was favorably impressed with Dr. Klingenberg's data and requested that such information be presented in the form of a declaration pursuant to 37 C.F.R. § 1.132. Accordingly, Applicants include herewith a declaration pursuant to 37 C.F.R. § 1.132 providing the data already presented to Examiner Sergent as well as additional data showing the importance of the claim recitations as amended above.

**Discussion of the Rejections Under 35 U.S.C. § 112, Second Paragraph**

Claims 1 to 24 have been rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter that Applicants regard as their invention. For the reasons detailed below, Applicants respectfully traverse this rejection.

Claims 3, 6, 9, and 10 were rejected as indefinite because Applicants allegedly failed to specify bases for the claimed weight percent. Applicants disagree respectfully.

Indeed, acceptability of the claim language depends on whether one of ordinary skill in the art would understand what is claimed, in light of the specification" (MPEP at 2100-208 Rev. 2, May 2004). The burden is on the Office to provide evidence or technical reasoning to support a contention that one of ordinary skill in the art would not be able to understand the meaning of the claim terms. MPEP § 2173.02. The standard to apply is whether the claims "define the patentable subject matter with a reasonable degree of particularity and distinctness" (id. at 2100-208 Rev. 2, May 2004) (emphasis in the original).

Applicants' specification clearly establishes the bases for the claimed weight percents. For example, Applicants' specification at page 6, lines 22 to 24, states:

[t]he amount of at least one diisocyanate within the isocyanate terminated prepolymer may range from about 20% to about 30% by weight of the reaction mixture (excluding solvent if present).

Also with respect to the diisocyanate, Applicants specification at page 7, lines 22 to 29, states:

In certain embodiments of the present invention, the at least one diisocyanate compound comprises  $\alpha,\alpha,\alpha,\alpha$ -tetramethylxylene diisocyanate (TMXDI™) (manufactured by Cytec Industries, Inc. of West Paterson, NJ). The TMXDI™ may be used alone, or in combination with one or more other diisocyanates such, for example, as those disclosed herein. In these embodiments, at least about 50 weight % or greater, preferably at least about 80 weight % or greater, or most preferably about 100 weight %, based upon the total weight of the at least one diisocyanate compound in the reaction mixture, comprises TMXDI™.

Similarly with respect to the at least one difunctional polyol component (*e.g.*, PPO),

Applicants specification at page 8, line 31 to page 9, line 2, states:

In certain preferred embodiments, the at least one difunctional polyol comprises at least about 75 weight % or greater, or more preferably at least about 95 weight % or greater of a PPO having a molecular weight of around 2,000, based upon the total weight of the at least one polyol in the reaction mixture.

With respect to the at least one isocyanate reactive compound, Applicants specification at page 9, lines 7 to 12, states:

The at least one isocyanate reactive compound is present within the reaction mixture (excluding solvent and one or more neutralizing agents if present) in an amount sufficient to provide an acid number based upon solids ranging from 17 to 22 mg of KOH/g. In this regard, the amount of at least one isocyanate reactive compound within the isocyanate terminated prepolymer may range from about 4% to about 6% by weight of the reaction mixture (excluding solvent if present).

With respect to the polyol, Applicants specification at page 7, line 31 to page 8, line 2, states:

The term "polyol" as used herein refers to any organic compound having 2 or more hydroxyl groups that are capable of reacting with an isocyanate group. The amount of at least one polyol within the isocyanate terminated prepolymer may range from about 65% to about 75% by weight of the reaction mixture (excluding solvent if present).

Thus, when the instant claims are read in light of the specification as they should be, one skilled in the art would indeed understand the bases for the claimed weight percents. *In re Cohn*, 169 USPQ 95 (C.C.P.A. 1971) (the claims must be read in light of the specification). Accordingly, reconsideration and withdrawal of the rejection of Claims 3, 6, 9, and 10 are requested respectfully.

Claims 6 and 21 have been rejected as indefinite for being dependent upon a cancelled claim. Applicants submit respectfully that, in view of the foregoing amendments, this rejection is now moot.

Claims 15 to 17, 19 and 22 to 25 have been rejected as indefinite because it is allegedly unclear what degree of crystallinity may be present and still satisfy the language "substantially free". Applicants submit respectfully that, in view of the foregoing amendments, this rejection is now moot.

Claim 25 has been rejected as being indefinite because the term "tacky" is allegedly unclear. Although Applicants disagree respectfully that the term "tacky" is unclear, Applicants have deleted this term from Claim 25 to advance prosecution of this patent application. Accordingly, the rejection is now moot.

#### **Discussion of the Rejection Under 35 U.S.C. § 103(a)**

Claims 1 to 4, 6 to 17, 19, and 21 to 25 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over U.S. patent application Publication No. US 2003/0083457 to Schafheutle et al. ("Schafheutle") in view of U.S. Patent No. 6,515,070 to Kobylanska et al. ("Kobylanska"), U.S. Patent No. 5,354,807 to Dochniak et al. ("Dochniak"), U.S. Patent No. 5,270,433 to Klauck et al. ("Klauck"), U.S. Patent No. 5,576,382 to Seneker et al. ("Seneker"), and U.S. Patent No. 4,855,077 to Shikinami et al. ("Shikinami") (also collectively referred to herein as "the applied prior art"). Applicants respectfully traverse this

rejection because the applied prior art does not teach or suggest Applicants' claimed invention.

To establish a *prima facie* case of obviousness, however, "there must be some teaching, suggestion or motivation in the prior art to make the specific combination that was made by the applicant." *In re Dance*, 160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998). "The invention must be viewed not with the blueprint drawn by the inventor, but in the state of the art that existed at the time." *In re Dembiczak*, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999) (quoting *Interconnect Planning Corp. v. Feil*, 227 U.S.P.Q. 543, 547 (Fed. Cir. 1985). "In other words, the examiner must show reasons that the skilled artisan, confronted with the same problem as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed." *In re Rouffet*, 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1458 (Fed. Cir. 1998).

#### Applicants' Claimed Invention

Applicants' claimed invention defines a process for forming an aqueous polyurethane dispersion with surprising properties relative to prior art aqueous polyurethane dispersions. Applicants have discovered that the particular claimed combination of **process step sequence and materials** produces an aqueous polyurethane dispersion that is substantially **non-crystalline**, has a weight average molecular weight ranging from **40,000 to 60,000 g/mol**, and the particle size of the polyurethane molecules in the dispersion is **less than about 2 microns**. The combination of such recitations surprisingly enables the polymer to be particularly suitable for use as a tacky, conductive adhesive for electronic applications.

In this regard, Applicants' claimed process for forming an aqueous polyurethane dispersion comprises the steps of: (1) providing an isocyanate terminated prepolymer by reacting (i) at least one diisocyanate comprising about 50% by weight or greater of  $\alpha,\alpha,\alpha,\alpha$ -

tetramethylxylene diisocyanate, (ii) at least one difunctional polyol comprising poly(propylene oxide) diol, and (iii) at least one isocyanate reactive compound comprising an acid functional group and at least two isocyanate reactive groups selected from the group consisting of a hydroxy, a primary amino, a secondary amino, and combinations thereof; (2) neutralizing the isocyanate reactive compound (iii) with a neutralizing agent comprising an amine group; (3) reacting the isocyanate terminated prepolymer with at least one chain terminating agent; (4) dispersing the isocyanate terminated prepolymer in water; and (5) reacting the isocyanate terminated prepolymer with at least one chain extending agent comprising an organic diamine selected from the group consisting of: ethylene diamine, 1,6-hexamethylene diamine, and 1,5-diamino-1-methyl-pentane, wherein ***the polyurethane polymer has a weight average molecular weight ranging from 40,000 to 60,000 g/mol***, wherein ***the particle size of the polyurethane polymer molecules in the aqueous dispersion is less than about 2 microns***, wherein the polyurethane polymer is ***non-crystalline***, and wherein ***the aforementioned steps are conducted sequentially (see, e.g., amended Claim 1)***.

As detailed below – and supported by the Declaration of Dr. Eric Klingenberg pursuant to 37 C.F.R. § 1.132 – one of ordinary skill in the art at the time of the present invention would not have been motivated to combine the applied prior art in such a way that would produce Applicants' claimed invention.

The Differences Between Applicants' Claimed Invention and The Applied Prior Art

There are many significant differences between the applied prior art and Applicants' claimed invention.

*Recited Sequence of Method Steps*

In the first instance, the applied prior art does not teach or suggest Applicants' claimed method wherein ***the recited steps are conducted sequentially*** or the effect of the recited sequence on particle size. Significantly, Schattheutte is completely silent with respect

to particle size and, at paragraph [0049] teaches that there is latitude with respect to neutralization and dispersion (Klingenberg Dec. at ¶ 12). Seneker, at column 7, line 30, likewise teaches that there is latitude with respect to the neutralization and dispersion process (id.). Kobylanska, at column 4, line 55, mentions that it is preferred to perform the neutralization with the dispersion (*i.e.*, addition of the prepolymer to an aqueous base solution to perform the neutralization and dispersion simultaneously) (id.). Dochniak at column 10, line 50, and Klauck, at column 11, line 5, teach the use of an aqueous dispersing medium (*i.e.*, water and base) and that there is latitude with respect to adding the aqueous dispersing medium to the prepolymer or the prepolymer to the aqueous dispersing medium (id.).

As Dr. Klingenberg explains in his declaration (with reference to Exhibit A of his declaration), the sequence of neutralization and dispersion do in fact influence the particle size of the polymer in the dispersion (Klingenberg Dec. at ¶ 13). Example A of Dr. Klingenberg's Exhibit B represents the prior teachings such as those found in Schafheutle, Kobylanska, Dochniak, Klauck and Seneker where neutralization and dispersion are carried out ***simultaneously*** through the addition of the prepolymer to an aqueous solution containing a base, triethyl amine, capable of salt formation with an acid such as a carboxylate group (id.). Example A of Dr. Klingenberg's Exhibit A represents the sequence of addition recited by the present invention where the prepolymer is neutralized with the base ***prior to*** dispersion in water (id.). As evidenced from the particle size data the latter sequence provides a dispersion that has a more uniform particle size distribution and all particles are <2 microns (id.). The methods taught by the applied prior art, in contrast, produce a dispersion having particles with a non-uniform distribution in size and a substantial fraction of the particles with sizes that exceed 2 microns (id.). Indeed, there is ***no reason*** that one of ordinary skill in the art at the time of the present invention would have been

motivated to perform Applicants' claimed sequence given the teachings of the applied prior art, let alone expect the resulting uniform particle size and particle size distribution for the polyurethane polymers prepared by Applicants' claimed invention.

*Claimed Molecular Weight Range*

Next, the applied prior art does not teach or suggest the importance of the claimed specific molecular weight range of 40,000 to 60,000 g/mol. Applicants have found that the combination of molecular weight and the other claimed characteristics of the polymer provide for a unique balance between lamination properties of the dry adhesive films prepared by coating the dispersion on a substrate and bond strength of the adhesive once the dry adhesive film is laminated to a second substrate (Klingenberg Dec. at ¶ 14). The applied prior art does not teach or suggest Applicants' claimed molecular weight range nor the benefits derived therefrom.

The Action alleges that Claims 1-4, 6-17, 19, and 21-25 are unpatentable with respect to the claimed molecular weight range given that Schafheutle, the only reference of the applied prior art that discloses a molecular weight, teaches that materials with a weight average molecular weight **greater than** 40,000 g/mol are preferred. Schafheutle's teachings with respect to molecular weight, however, are confusing at best. For example, Schafheutle also discloses a preferred Mw of >20,000 g/mol in the Abstract, while citing a preferred MW of >50,000 g/mole at paragraph [0011] in addition to its teaching of molecular weight **greater than** 40,000 g/mol (Klingenberg Dec. at ¶¶ 15 to 17). Schafheutle is completely silent with respect to an upper molecular weight limit or boundary (id. at ¶ 16). Applicants, in contrast, have shown the importance of an upper limit with respect to the molecular weight of polyurethanes according to the claimed invention in terms of lamination quality.

Lamination quality is assessed through the ability of the adhesive under a given pressure and temperature to make intimate contact with the substrate, including substrates



with a specific surface roughness or features (such as those typical in electronic devices due to wire bond lines) without leaving voids (spaces where the adhesive does not contact the substrate) (Klingenberg Dec. at ¶ 18). Because most electronic devices require good connection between conductors to enable proper operation, it is undesirable to have the insulating air gap between these substrates (id.). It is also undesirable to use excessive pressure or temperature to enable the adhesive to flow well enough to provide adequate contact as the application of such extremes often results in damage to the electronic components (id.). The lamination quality for these types of materials is related to the tack and cross-over temperature for the material (id.). The cross over temperature is defined as the temperature at which the loss or liquid like modulus is dominant over the storage or elastic modulus of the material (id.).

The bond strength, or adhesive strength, of an adhesive is related to the material's ability to bind to the substrates surface, adhesive strength, and the material's ability to be separated from its own cohesive forces (cohesive strength) (Klingenberg Dec. at ¶ 19). The adhesive strength is mainly controlled by the composition of the adhesive with relation to the substrate, while the cohesive strength is related to composition and the number of chain entanglements or Mw (id.). While bond strength and lamination quality are related to the Mw of the polymeric material, the unique molecular weight range that provides adequate lamination quality and bond strength is not known or discussed in the prior art (Klingenberg Dec. at ¶ 20).

Exhibit B of Dr. Klingenberg's declaration provides data that reveals the crossover temperature as a function of molecular weight. According to Dr. Klingenberg, all materials were made using the claimed process with Example C being representative of a material with an Mw of 30,000 g/mole, Example D being representative of a material with an Mw of 50,000 g/mol, and Example E being representative of a material with an Mw of 90,000 g/mol

(Klingenberg Dec. at ¶ 22). It is clear from this data that Example D has a cross-over temperature intermediate between that of Examples C and E (id.).

Exhibit C of Dr. Klingenberg's declaration is a photograph further illustrating the benefits of Applicants' claimed invention. Exhibit C includes a frosted glass slide (Fisher Scientific Catalog number 12-544-5CY) that has been in contact with the adhesive film samples of various weight average molecular weights (Mw) at 50°C under a 1.5 kg weight for 1 hour (Klingenberg Dec. at ¶ 23). The adhesive films were prepared by directly coating the wet dispersion on PET release liner at a weight sufficient to give 4 mil dry thickness (id.). The films were air dried for 12 hrs and then dried for 1 hour at 80°C under a nitrogen flow (id.). According to Dr. Klingenberg, the description of the samples is as follows: Sample E is a picture of the glass slide with no coating, Sample F used the 35,000 Mw adhesive, Sample G used the 45,000 Mw adhesive, Sample H is with the 50,000 Mw adhesive, Sample I is with the 55,000 Mw adhesive, Sample J is with the 68,000 Mw adhesive, and Sample K is with the 92,000 Mw adhesive (id.). According to Dr. Klingenberg, the "white" appearance of the slides is where the adhesive did not make good contact with the glass slide (id.). For samples F through I there is adequate contact with minimal voids (id.). However, Sample J, the 68,000 Mw sample, has large areas near the center of the slide that have very poor contact with the glass slide (id.). This indicates the upper limit of the Mw is near 60,000 Mw for adequate lamination properties (id.).

Exhibit D of the Klingenberg declaration further illustrates the maximum peel strength for the adhesives as a function of Mw. Peel strength was measured according to the specification described in the present patent application and the data was normalized to the 50,000 g/mole material (Klingenberg Dec. at ¶ 24). This data indicates that the max peel strength is low for materials below 40,000 g/mole and increases with Mw prior to decreasing

again after 68,000 g/mole (id.). This clearly indicates that there is a preferred molecular weight range for this material where the adhesive strength is greatest (id.).

Thus, from the examples in Exhibits C and D of Dr. Klingenberg's declaration, it is conclusive that there is a desired weight average molecular weight range of 40,000 to 60,000 g/mol for the adhesive that gives the best combination of lamination quality and adhesive strength (Klingenberg Dec. at ¶ 25). Indeed, Dr. Klingenberg has demonstrated that it is possible to have a material where the Mw is too high and, thus, has unacceptable lamination or adhesion qualities (Klingenberg Dec. at ¶ 22). There is simply no evidence of record that one of ordinary skill in the art at the time of Applicants' claimed invention and presented with the applied prior art would have been motivated to produce a polyurethane according to the present invention having the claimed molecular weight range.

*Applicants' Polyurethane Polymers are Non-Crystalline*

Next, the applied prior art does not teach or suggest the claim recitation that polyurethane polymer is **non-crystalline**. The use of non-crystalline polymers as adhesives in devices where the ionic conductivity of the adhesive material is necessary for proper device operation is critical to maintaining consistent device performance as a function of environmental cycling (Klingenberg Dec. at ¶ 26). Because the degree of crystallinity is affected in polymers by the temperature of the crystalline melt and the rate of cooling, exposure of these types of polymers to different environmental conditions, *i.e.*, temperature and humidity, can bring about changes in the degree of crystallinity of the polymeric material (id.). For ionically conductive polymers, it is only the amorphous regions of the polymer film that contribute to ionic conductivity, not the crystalline regions (id.). Polymers that crystallize and can undergo changes in crystallinity upon environmental cycling negatively affect the ionic conductivity of the polymer and thus device performance (id.). Therefore, it is

preferable to have polymeric adhesives that are free of crystallinity as measured by Differential Scanning Calorimetry (DSC) (id.).

The Action mistakenly alleges that the mere use of polypropylene glycol in making the polyurethane would result in an amorphous or non-crystalline polymer and, thus, the significant absence of crystallinity would not be an unexpected property (Action at 5). Applicants' claimed invention, however, recites "**at least one** difunctional polyol comprising poly(propylene oxide) diol" (see, e.g., Claim 1; emphasis added) and, therefore, does not preclude the presence of other polyols, which may or may not impart crystallinity to the polyurethane (Klingenberg Dec. at ¶ 28).

For example, Exhibit E of Dr. Klingenberg's declaration provides DSC data for polymers that were made using the claimed process described in the present specification using TMXDI as the isocyanate, but where the polyol component is made up of poly(propylene oxide) diol and another polyol (Klingenberg Dec. at ¶ 29). Referring to Exhibit E, Example Q is a polyurethane that was made where the polyol component of the polyurethane is made up of 25% hexane diol adipate and 75% poly(propylene oxide)diol by weight (id.). Example R is a polyurethane that was made where the polyol component of the polyurethane is made up of 25% of neopentyl glycol adipate and 75% poly(propylene oxide) diol by weight (id.). In each case the DSC analysis clearly indicates the presence of a heat of fusion peak from the melting of crystalline regions in each Example Q and R (id.). Therefore, it is indeed possible to have polyurethanes with substantial crystallinity even though a significant fraction of the molecule comprises poly(propylene oxide)diol (id.).

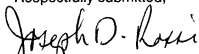
Thus, the data provided by Dr. Klingenberg demonstrates that there are significant differences between the inventions defined by the above-identified independent claims and the teachings of the applied prior art. Accordingly, reconsideration and withdrawal of the rejections under 35 U.S.C. § 103(a) are requested respectfully.

**Conclusion**

Applicants believe that the foregoing constitutes a complete and full response to the Action of record. Applicants respectfully submit that this application is now in condition for allowance. Accordingly, an indication of allowability and an early Notice of Allowance are respectfully requested.

The Commissioner is hereby authorized to charge the fee required and any additional fees that may be needed to Deposit Account No. 01-0493 in the name of Air Products and Chemicals, Inc.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Joseph D. Rossi". The signature is fluid and cursive, with the first name "Joseph" and last name "Rossi" clearly distinguishable.

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